

# NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

## WASTE TREATMENT LAGOON

(no.)  
CODE 359

### DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

### PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

### CONDITIONS WHERE PRACTICE APPLIES

Where the lagoon is a component of a planned agricultural waste management system.

Where treatment is needed for organic wastes generated by agricultural production or processing.

On any site where the lagoon can be constructed, operated, and maintained without polluting air or water resources.

To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

This standard is not applicable to treatment of untreated human waste.

### CRITERIA

#### GENERAL CRITERIA FOR ALL LAGOONS

**Laws and Regulations.** All federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed. Laws and regulations of particular concern include those involving water rights, land use, land disturbed by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Where South Dakota Department of Environment and Natural Resources (DENR) approval is to be obtained, DENR requirements must be applied to this practice.

South Dakota dam safety requirements shall be met for construction of facilities utilizing embankments.

**Location.** Waste treatment facilities shall not be located within the 100-year frequency flood plain unless the structure is protected from inundation and damage that may occur during the 100-year frequency flood event.

Waste treatment facilities cannot be located closer than 1,000 feet from an existing public water well or drinking water source nor 250 feet from an existing nonowned private water well or drinking water source. Waste treatment facilities shall not be located closer than 150 feet from a water well or drinking water source owned by the operator.

Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

**Soils and foundation.** The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

Conservation practice standards are reviewed periodically and updated if needed. The current version of this standard is on our eFOTG web site available at [www.sd.nrcs.usda.gov](http://www.sd.nrcs.usda.gov) or may be obtained at your local Natural Resources Conservation Service.

The lagoon shall have a bottom elevation that is a minimum of two feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

**Clay liners.** Clay liners must be at least 18 inches thick and compacted to at least 95 percent of standard maximum dry unit weight, and at water content within 2 percent of optimum as determined by ASTM D698. Where DENR approval will be obtained, the compacted clay liner must meet South Dakota regulatory requirements.

**Flexible membranes.** Flexible membranes shall be designed to be waterproof (including seams) and designed for permanent exposure to ag waste, soils, and sunlight and must have a minimum thickness of 30 mil.

**Groundwater monitoring.** Where waste storage facilities are located over shallow aquifers or where discharge to groundwater may occur, regularly sampled groundwater monitoring wells or a Groundwater Discharge Permit may be required. For each affected site, these requirements will be as specified by DENR.

**Livestock access.** Livestock shall be prohibited access to the interior of waste treatment facilities.

**Required volume.** The lagoon shall have the capability of storing the following volumes:

Volume of accumulated sludge for the period between sludge removal events;

Minimum treatment volume (anaerobic lagoons only);

Volume of manure, wastewater, and other water and substances accumulated during the treatment period;

For exposed lagoon surfaces, depth of mean annual precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period;

Mean annual runoff (if the structure receives runoff from an open lot or other drainage area);

Depth of the 25-year, 24-hour storm precipitation on exposed lagoon surface area (at the required volume level).

25-year, 24-hour precipitation runoff (if structure receives runoff from an open lot or other drainage area);

Additional storage as may be required to meet management goals or regulatory requirements.

Uncontaminated storm water runoff shall be diverted away from the waste treatment facility wherever appropriate.

Structures designed to divert runoff must be designed to carry the peak flow expected during the 25-year frequency, 24-hour duration precipitation event.

**Treatment period.** The treatment period is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste or as required by local, state, and federal regulations.

**Waste loading.** Daily waste loading shall be based on the maximum daily loading considering all water and waste sources that will be treated by the lagoon. Reliable local determinations or laboratory test data should be used if available. Information on waste production is provided in Chapter 4 of the Natural Resources Conservation Service Agricultural Waste Management Field Manual (AWMFM).

**Embankments.** The minimum elevation of the top of the settled embankment shall be one foot above the lagoon's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. Where required compaction is less than 95 percent of ASTM D698 standard maximum dry unit weight, the fill height increase for settlement shall not be less than 5 percent. Minimum freeboard for facilities permitted by DENR must meet state regulations.

Earth embankment slopes must be designed to be stable, and must be three horizontal to one vertical or flatter.

The minimum top widths are shown in Table 1.

**Table 1 – Minimum Top Widths**

Total Embankment Height at Centerline, ft.	Top Width, ft.
9.9 or less	8
10 – 19.9	10
20 – 24.9	12
25 – 29.9	14
30 – 35	15

Note - SD DENR may require other top widths.

**Excavations.** Unless supported by a soil investigation, excavated side slopes shall be no steeper than two horizontal to one vertical.

Wind and wave protection. Erosion protection shall be provided for earthen waste treatment lagoons having a five-acre or larger liquid surface at maximum operating level.

**Edges.** The edges of all earth lagoons below the planned waterline must be constructed on approximately three horizontal to one vertical (3:1) slopes to reduce areas of shallow water and to inhibit weed growth.

**Inlet.** Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

For inlets carrying solids, the inlet should be designed to deposit waste near the center of the side of the lagoon or storage area. Minimum pipe diameter shall be 10 inches except as recommended by equipment manufacturers. The preferred pipe slope for gravity flow is one percent. Flatter slopes may be used where provision is made to clear blockages.

**Outlet.** Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon.

**Facility for drawdown.** Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc., shall permit

drawdown without causing erosion or damage to liners.

Accumulated solids removal. Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of ponds and type of seal, if any.

**Erosion Protection.** Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner.

**Safety.** Design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

#### **ADDITIONAL CRITERIA FOR ANAEROBIC LAGOONS**

**Loading rate.** Anaerobic lagoons shall be designed to have a minimum treatment volume based on VS loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 or according to state regulatory requirements, whichever is more stringent.

**Operating levels.** The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the Operation and Maintenance (O&M) plan.

**Depth Requirements.** The minimum depth at maximum drawdown shall be six feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

## **ADDITIONAL CRITERIA FOR NATURALLY AEROBIC LAGOONS**

**Loading rate.** Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD5 loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be as indicated by AWMFH Figure 10-25 or according to state regulatory requirements, whichever is more stringent.

**Operating levels.** The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

**Depth requirements.** The minimum depth at maximum drawdown shall be two feet. The maximum liquid level shall be five feet.

## **ADDITIONAL CRITERIA FOR MECHANICALLY AERATED LAGOONS**

**Loading rate.** Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of one pound of oxygen for each pound of daily BOD5 loading.

**Operating levels.** The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

## **CONSIDERATIONS**

### **GENERAL**

Lagoons should be located as close to the source of waste as possible.

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

### **CONSIDERATIONS FOR MINIMIZING THE POTENTIAL FOR AND IMPACTS OF SUDDEN BREACH OF EMBANKMENT OR ACCIDENTAL RELEASE FROM THE REQUIRED VOLUME**

Features, safeguards, and/or management measures to minimize the risk of embankment failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 2 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in the "Potential Impact Categories from Breach of Embankment or Accidental Release" may be significantly affected:

An auxiliary (emergency) spillway;

Additional freeboard;

Storage volume for the wet year rather than normal year precipitation;

Reinforced embankment - such as, additional top width, flattened and/or armored downstream side slopes;

Secondary containment;

Water level indicators or recorders.

### **POTENTIAL IMPACT CATEGORIES FROM BREACH OF EMBANKMENT OR ACCIDENTAL RELEASE**

Surface water bodies -- perennial streams, lakes, wetlands, and estuaries;

Critical habitat for threatened and endangered species;

Riparian areas;

Farmstead, or other areas of habitation;

Off-farm property;

Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

The following should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in the above "Potential Impact Categories from Breach of Embankment or Accidental Release" may be significantly affected:

Outlet gate locks or locked gate housing;

Secondary containment;

Alarm system;

Another means of emptying the required volume.

#### **CONSIDERATIONS FOR MINIMIZING THE POTENTIAL OF LAGOON LINER SEEPAGE**

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed under the "Potential Impact Categories for Liner Seepage" may be affected.

#### **POTENTIAL IMPACT CATEGORIES FOR LINER SEEPAGE**

Any underlying aquifer is at a shallow depth and not confined;

The vadose zone is rock;

The aquifer is a domestic water supply or ecologically vital water supply;

The site is located in an area of carbonate rock (limestone or dolomite).

Should any of the potential impact categories listed in the above "Potential Impact Categories for Liner Seepage" be affected, consideration should be given to the following:

A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that

specific discharge is less than  $1 \times 10^{-6}$  cm/sec.;

A flexible membrane liner;

A geosynthetic clay liner (GCL) flexible membrane liner;

A concrete liner designed in accordance with slabs on grade criteria in NRCS Practice Standard 313, Waste Storage Facility, for fabricated structures requiring water tightness.

Considerations for minimizing the impact of odors.

For sites located where odors are a concern, the following should be considered:

Reduce loading rates of anaerobic lagoons to less than one half the values of AWMFH Figure 10-22.

Covering the lagoon with a suitable cover.

Using naturally aerated or mechanically aerated lagoons.

Using composting in conjunction with a solid waste system rather than a liquid or slurry system.

Using an anaerobic digester and biogas capture system.

#### **PLANS AND SPECIFICATIONS**

Plans and specifications for installing waste treatment lagoons shall meet this standard and shall describe the requirements to achieve the intended purpose.

#### **OPERATION AND MAINTENANCE**

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume as planned. In addition, the plan shall include a strategy for removal and disposition of treated waste with the least environmental damage. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include

site-specific provisions for emergency actions that will minimize these impacts.

## REFERENCES

South Dakota Department of Environment and Natural Resources (DENR) references

Animal Waste Management to Protect Water Quality (EC 895) – South Dakota Cooperative Extension Service

Livestock Waste Facilities Handbook (MPWS-18) Midwest Plan Service

Concrete Manure Storages Handbook (MWPS-36) Midwest Plan Service